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TREATMENT OF PEAR LEAF-BLIGHT * IN THE ORCHARD.

By M. B. WAITE.

[Plates XXXII, XXXIII.]

The experiments here described were carried on in the orchard of the Old Dominion Fruit Company, on the James River, near Scotland, Va. This orchard consists almost exclusively of standard Bartlett pears and contained originally 22,000 trees, of which at least 16,000 are still standing. The trees are now 19 years old and the greater part of them are in fairly good condition, except for pear leaf-blight, which for several years past has defoliated the trees during the month of July. This defoliation in midsummer deprives the trees of the use of their leaves during half of the season, and no doubt seriously interferes with their vigor. The cultivation has been fairly good. The trees were headed very low, and the lower branches, until the past season, extended nearly to the ground, but during the past winter they have been trimmed up. Most of the trees do not make a very strong growth, nor do they continue to grow long into the summer. Only occasionally does the general growth of twigs on a tree exceed 1 foot, and often it is much less. The fact that these trees have been regularly defoliated with leaf-blight made this an excellent place for experiment, particularly because of the availability of uniform blocks of similar trees.

The appearance of the disease in question year after year to about the same extent makes it an easy one to experiment upon. In 1892 five sprayings with the 50-gallon formula of Bordeaux mixture entirely prevented the leaf-blight. The dates of the sprayings were April 28, May 15 and 30, and June 14 and 29. At the time of the first treatment the young leaves were just fairly expanded. The object of the sprayings was simply to prevent the disease on about 160 trees as a part of another experiment of an entirely different character. The spraying was thoroughly done and the treated trees held their leaves to the close of the season and showed scarcely a spot of leaf-blight, while the

* *Entomosporium maculatum* Lév.

rest of the orchard became entirely bare by the 1st of August. It were thought at the time that five treatments were probably more than were necessary. The question then arose as to how few sprayings would be necessary to prevent the disease. It was deemed best, therefore, in planning this experiment to take the standard fungicide and find the least number of treatments that would prevent the disease and the best times for making them. On account of the beneficial results from spraying the experimental trees in 1892, the owners decided to spray the whole orchard in 1893. In doing this the suggestions of the Department were followed quite closely and a record of the work was kept, so that it furnishes an interesting example of the success of the treatment and its cost when done on a large scale.

The work, therefore, may properly be discussed under two heads, (1) an experiment to determine the least number of treatments with Bordeaux mixture necessary to prevent leaf-blight, and (2) an experiment to ascertain the actual cost of treating a large orchard with Bordeaux mixture four times.

TREATMENT TO PREVENT LEAF-BLIGHT.

The plan of the first experiment was as follows: A portion of the orchard was selected which was uniform and where there were few missing trees. Eight plats of 20 trees each (two rows of 10 trees each) were laid off side by side and numbered 1 to 8. A control plat of the same size as the numbered plats, 2 rows wide and 10 rows long, was left at the beginning of the series, and another at the end. Continuing from the second control plat, 8 duplicate plats were laid off and numbered 1¹ to 8¹. A third control plat followed 8¹.

Plats 1 and 1¹ were treated April 24, 1 treatment.

Plats 2 and 2¹ were treated May 1, 1 treatment.

Plats 3 and 3¹ were treated May 15, 1 treatment.

Plats 4 and 4¹ were treated June 1, 1 treatment.

Plats 5 and 5¹ were treated May 1 and 15, 2 treatments.

Plats 6 and 6¹ were treated May 1 and 15 and June 1, 3 treatments.

Plats 7 and 7¹ were treated May 1 and 15 and June 1 and 15, 4 treatments.

Plats 8 and 8¹ were treated June 1 and 15, 2 treatments.

It was desired to determine the most critical time in the treatment of the disease by making one single treatment at different times and observing which one did the most good. The Bordeaux mixture used was the 50-gallon formula, 6 pounds of copper sulphate in 50 gallons of water, with enough lime to neutralize all the copper. To avoid complications only the single strength of the fungicide was tried, and the experiment was limited to ascertaining the dates and the number of treatments. The spraying was superintended by Mr. W. H. Berryman, the manager of the orchard. The first application was made just after the trees had come apparently into full foliage, at which time no leaf-blight had yet appeared. The four treatments of plats 7 and 7¹ were given so as to be sure to prevent the disease, and the others were simply intermediates.

Results.—The orchard was visited and careful notes taken on August 2 and again on October 12. By August 2 the control plats had lost the greater part of their foliage. Scarcely one-fifth remained on these trees, and this was rapidly falling, it being badly affected by leaf-blight. The contrast between unsprayed and the sprayed foliage was very striking. All the sprayed trees, including the single treatments, looked exceedingly well as compared with the controls, except the trees sprayed April 24. These showed but little improvement over the unsprayed controls. The other plats, which had been sprayed once, while appearing to retain full foliage, had begun to shed their leaves. There were fewer spots on the leaves of the trees sprayed May 15 than on those sprayed May 1, and still less on those sprayed June 1. In fact, the latter appeared at that time to be an almost perfectly successful treatment and the plat was scarcely inferior to those which received two or even four treatments. By October 12 the controls and also the plat sprayed early were completely defoliated. All the trees were beginning to shed normally a little, so that slight differences had developed which were not apparent on the first visit. The conclusions from a study of these results are as follows:

(1) The earliest treatments gave the poorest results, and of the single treatments there was an increase in effect up to June 1. Between May 15 and June 1 there was but slight difference.

(2) Two sprayings (on May 1 and 15 or on May 1 and June 1) left so little to be desired that they may be considered sufficient treatment for an orchard. The improvement from the additional third and fourth treatments was very slight and was visible only at the close of the season.

(3) Pear leaf-blight on orchard trees in this section of Virginia does not commence its work early in the season, but is a late-appearing fungus. It develops on the foliage after the leaves are quite mature and continues to multiply after August 1. The attacks of fungi which caused differences to appear between plats 2 to 8 came mostly after August 2, long after the spraying was done, thus indicating that it was the thoroughness with which the trees were covered or the amount of fungicide on them that was important rather than the time when it was applied.

(4) From the results it would seem that the first spraying should be postponed until late in the spring, in order to have the fungicide fresh on the leaves during the first attacks of the disease, but should be made early enough to get ahead of the fungus. The second treatment should be made just ahead of the principal attack of the fungus and late enough so as to last well through the season. A leaf thoroughly sprayed once as late as June seemed to be protected for the rest of the season. The disadvantage of the early treatment is apparently due to the long exposure of the fungicide to the weather before the critical time.

(5) These results indicate that for Virginia the first treatment should be made between May 15 and June 1 or even on the latter date, and for regions farther north at correspondingly later dates; or to state the proposition in general terms, the first spraying should be given from four to six weeks after the trees blossom, and the second treatment should be made one month later.

The question naturally arises whether these results can be relied upon without repetition during a series of years. Of course one would feel much safer if they were repeated at least one season. Pear leaf-blight, however, is well known to be a very regular disease, both as to prevalence and severity, and exceptionally uniform during different seasons. This constant character of the disease makes the conclusions much safer than they would be with almost any other fungous disease.

It may be well to state that these conclusions do not apply to nursery stock or to trees which for any reason make a new growth late in the season. In another part of the orchard in question a block of trees which had been pruned back severely to renew the whole top was sprayed four times, the last treatment being on June 30. These trees made 3 to 5 feet of growth and at the close of the season the last 6 or 8 inches of the more vigorous shoots, which had doubtless grown after the last treatment, were either defoliated or spotted with leaf-blight. From this it is evident that trees putting out new growth require additional sprayings to protect the new leaves as they appear.

TREATMENT OF THE ORCHARD AS A WHOLE.

The orchard as a whole was sprayed with the same strength of Bordeaux mixture as the experimental plats, i. e., the 50-gallon formula. In making the mixture a method of preparing and using a stock solution of copper sulphate was devised, which saved the time required to weigh out and dissolve the copper salt for each separate quantity of the mixture. At the suggestion of the writer the plan has since been tried in New Jersey and New York, and has proved to be a great saving of time where a large amount of spraying is to be done. A barrel holding 50 gallons should be selected and 100 pounds of copper sulphate (large crystals can be used) suspended in a basket or a piece of coarse sacking in the upper part of it. The barrel is then filled with water. In the course of a day or two all the copper will be dissolved. The basket is then removed and more water is added until the barrel is again full. This second addition of water is necessary to fill the space which was occupied by the copper before it was dissolved. Each gallon of this solution will contain 2 pounds of the copper salt. If the copper salt is placed in the bottom of the barrel, it will be dissolved only with difficulty. It should be noted that considerably less than 50 gallons of water is added, owing to the fact that the copper occupies some of the space, but that the final solution of copper sulphate and

water makes the 50 gallons. If a greater or less amount of stock solution is to be made up, the vessel must first be measured and a mark made to indicate the required amount, and then the solution made up to this mark. For example, if 40 pounds of copper is desired in stock solution, do not add 20 gallons of water to it, because the resulting solution would then contain more than 20 gallons, but instead make a 20-gallon measure on some convenient vessel and make the solution up to the 20-gallon mark.

The lime may also be kept ready mixed for use. It should be slaked and run off as a paste, and should then be stored in barrels buried in the ground. A tight barrel should be placed beside the copper sulphate barrel and filled about one-fourth full of the lime paste, and then water should be added until the barrel is nearly full.

In making up the Bordeaux mixture it is only necessary to draw off the required amount of copper solution and pour it into the tank while it is being filled with water. When the tank is nearly full add several pailfuls of the milk of lime, obtained by stirring the lime paste and water together, allowing it to settle a few seconds and then dipping it off. By using the yellow prussiate of potash test* it is easy to determine when sufficient lime has been added. The operator soon learns the correct color of the mixture, and this serves as a guide as to when to make the test. All the material which goes into the tank should be strained through a sieve. In the case in question a sieve was made by tacking a square foot of rather heavy brass wire netting, with meshes 20 to the inch, over the end of a funnel-shaped box.

The spraying outfit used was a 150-gallon hogshead, mounted on a wagon. In it was placed a No. 2 Nixon pump, supplied with two hose, each 24 feet long, and a 6-foot brass tube, with stopcock and Vermorel nozzle. One man drove and pumped while two men directed the spray. As they passed between the rows each man sprayed one side of a row. The brass tubes enabled them to cover the trees thoroughly from the ground, except the tops of a few of the tallest. The nozzles gave a fine, misty spray. The endeavor was to touch every part of the tree with the spray, but only for an instant. It was generally necessary to stop the team a few seconds at a few of the trees, but the greater part of the work was done while the team was moving slowly along. If the trees had been small they could have been covered without stopping. Two outfits as described above were used in the work, and it took twelve days to go over the entire orchard once. It was sprayed four times, the cost of the whole work† being about as follows:

*This test is simply the addition of a few drops of a solution of ferrocyanide of potassium. This solution is made by dissolving one-half ounce of the substance in 2 or 3 ounces of water, and if on the addition of a few drops to the Bordeaux mixture a brownish color appears, more lime should be added.

†The entire expense of the work herein described was borne by the Old Dominion Fruit Company.

1 white man, at \$1.25 per day, 48 days.....	\$60
5 colored men, at 75 cents per day, 48 days.....	180
2 teams, with wagons, at \$2 each per day, 48 days	192
Total labor	\$432
Chemicals	70
Wear and tear on sprayers	20
Grand total.....	\$522

It will be seen from the foregoing that the cost of treating one tree four times (estimating 16,000 trees) was 3 cents and 2 mills, the cost of treating one tree once was 8 mills, and the cost of treating one acre (estimating 203 acres) was \$2.56.

It is undoubtedly true that the four treatments were more than were necessary, and that two sprayings well done would be all that could be desired, as shown by the experimental plats. In other words, had the facts brought out by the experiment been known at the beginning, the cost of spraying the orchard could have been reduced one-half.

It is important to notice that the principal cost was the labor in applying the mixture, the men and teams costing more than four-fifths of the total amount. The cost of the fungicide and apparatus was a relatively small matter. This suggests that future experiments should be directed toward improving the means of distributing the fungicide, and thereby reducing the amount of labor required.

DESCRIPTION OF PLATES.

PLATE XXXII.—Bartlett pear tree sprayed with Bordeaux mixture.

PLATE XXXIII.—Bartlett pear tree untreated and defoliated by leaf-blight.

EXPERIMENTS WITH FUNGICIDES TO PREVENT LEAF-BLIGHT OF NURSERY STOCK.

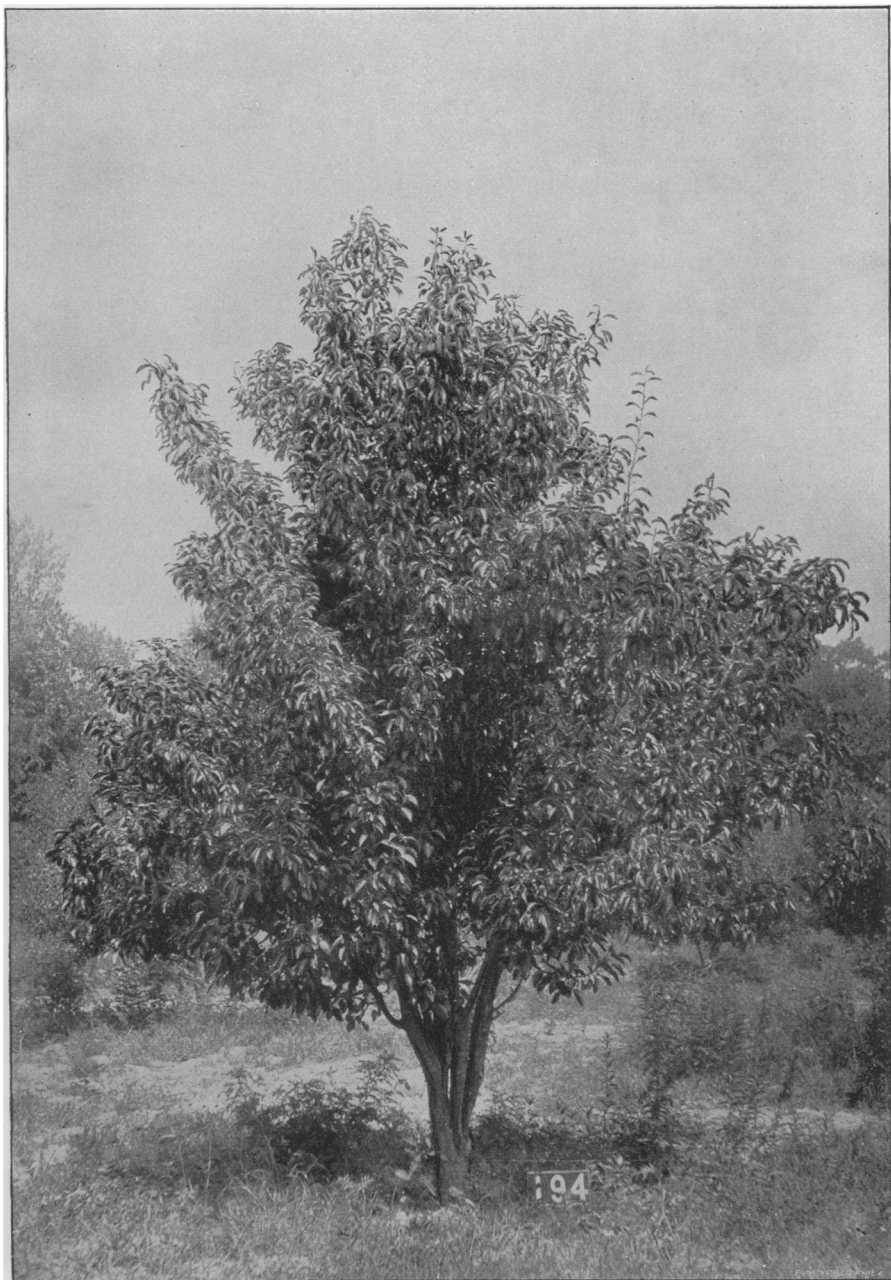
By D. G. FAIRCHILD.

The following paper gives details of experiments carried on at Geneva, N. Y., to prevent leaf-blight of pear and other seedlings. An abstract of the work has already been published,* but in this paper there will be given in detail the various formulæ used, with notes upon chemical reactions and upon the effects of the different substances employed.

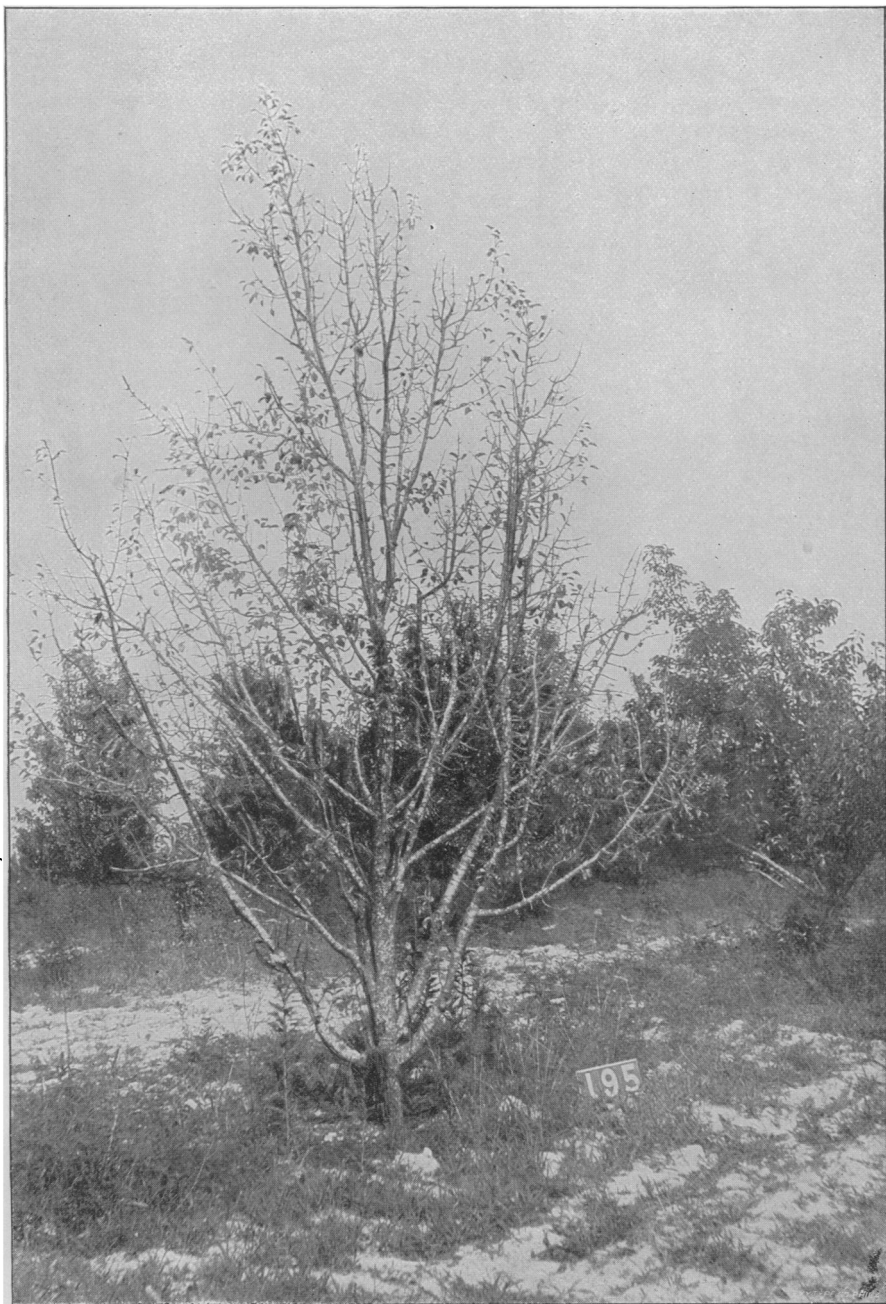
EXPERIMENTS WITH PEAR SEEDLINGS.

The experiment with pear seedlings was carried on in coöperation with Prof. S. A. Beach, botanist of the New York State Experiment Station. I wish here to express my thanks to him for his careful attention to the planting and cultivation of the seedlings, for his assistance in their treatment, and for his valuable aid in taking notes upon the results.

* Report of Sec. of Agr. for 1892, pp. 224-229.



BARTLETT PEAR TREE SPRAYED WITH BORDEAUX MIXTURE.



BARTLETT PEAR TREE UNTREATED AND DEFOLIATED BY LEAF-BLIGHT.